

PRELIMINARY DATA SUMMARY

February 1990

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

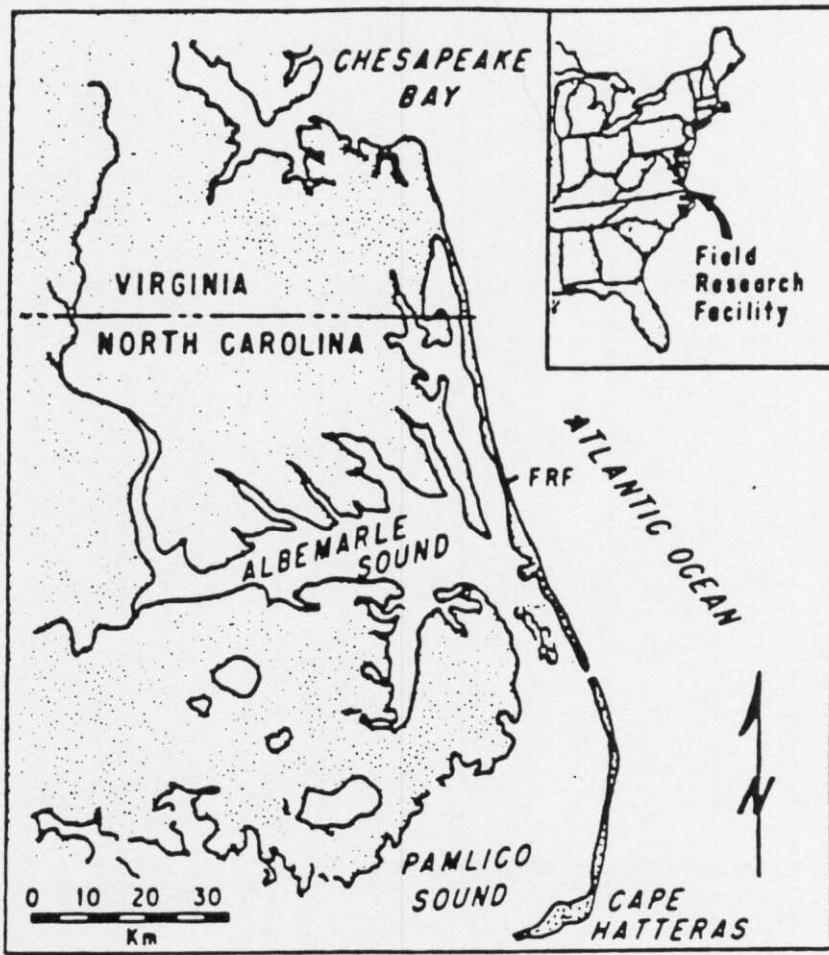


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

FEB 1990

Gage ID	Description/Remarks	Depth at Sensor	Day of the month																											
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
616	Barometric Pressure		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Analog Record	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation		Gage Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
			Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
624	Air Temperature		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
			Analog Record	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Supplemental Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

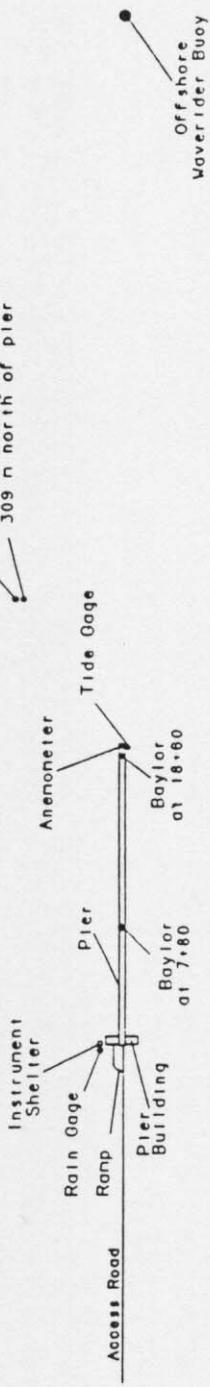
Gage Status              Daily Observation              Analog Record              Data Collected  
 Operational = \*              Complete = \*              Complete = \*              All = \*  
 Partial = /              Partial = /              Partial = /              Partial = /  
 Non-Operational = -              None = -              None = -              None = -

True North



Pier Building at 0.40 to 1.00  
Anemometer at 0.70  
12 Inch Rain Gage at 0.30  
Instrument Shelter at 0.40

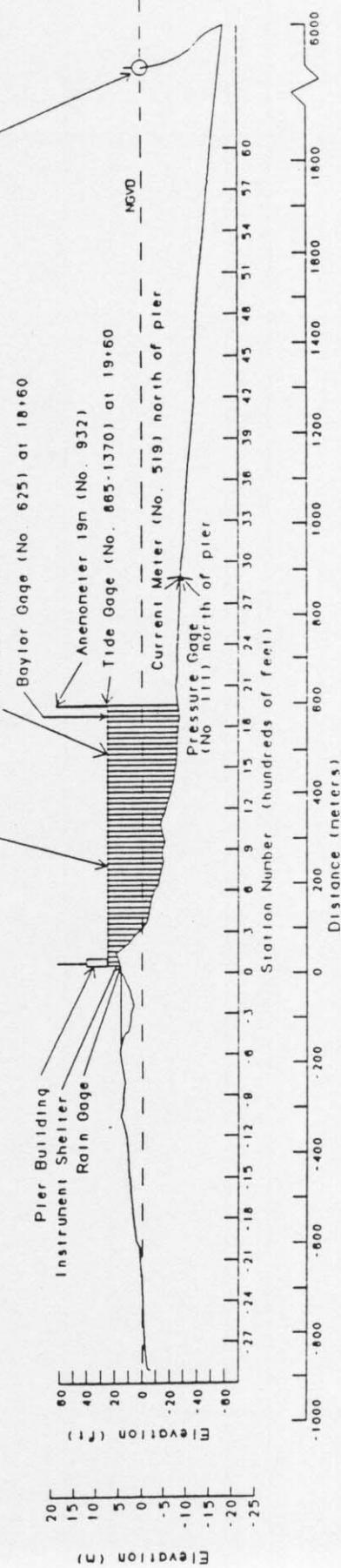
Current Meter  
320 n north of pier  
Pressure Gage  
309 n north of pier



### CURRIUCK SOUND

Raylor Gage (No. 645)  
at 7.80

Pier Deck 7.6 n



### ATLANTIC OCEAN

Pressure Gage  
(No. 309)

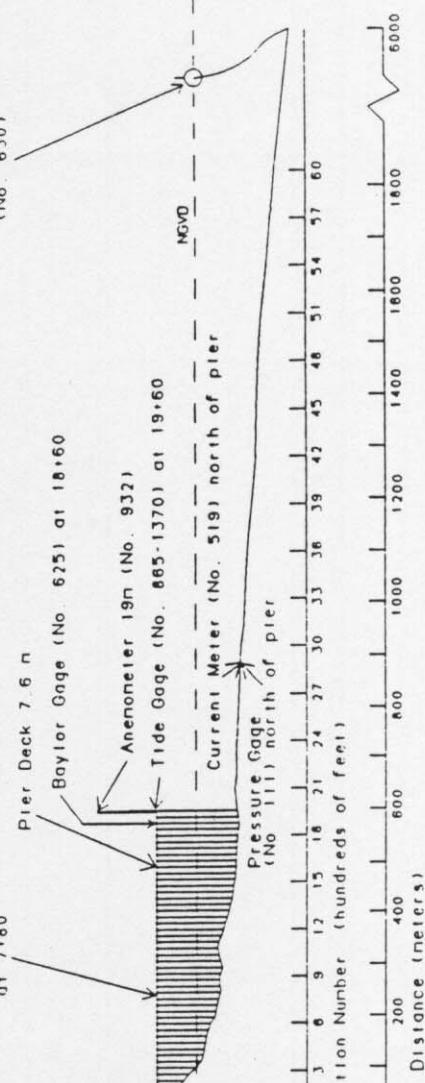


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

Feb 1990

Day	Hour	** Wind	** Wind	Temperature	Atm	Precipitation ***
		Speed m/sec	Direction deg TN	deg C	mb	mm
1	100	4	1	7.8	1024.3	0
	700	6	42	8.3	1023.6	0
	1300		Power Failure			0
	1900	7	197	15.8	1018.9	0
2	100	6	214	14.6	1017.9	0
	700	6	204	14.0	1016.5	0
	1300	7	225	19.5	1013.8	0
	1900	7	205	18.5	1012.1	0
3	100	6	234	15.1	1014.5	0
	700	3	246	13.9	1017.5	0
	1300	8	38	10.0	1018.2	0
	1900	4	99	10.7	1014.8	0
4	100	9	206	17.1	1010.4	0
	700	3	218	14.2	1008.4	0
	1300	6	217	19.4	1003.3	0
	1900	5	261	16.1	1002.0	0
5	100	15	357	7.0	1009.4	0
	700	13	1	4.3	1017.2	6
	1300	9	352	4.4	1021.6	0
	1900	5	1	4.5	1024.3	0
6	100	2	138	2.5	1024.7	0
	700	5	217	5.4	1025.0	0
	1300	6	230	12.1	1021.9	0
	1900	6	202	11.1	1020.3	0
7	100	3	177	8.8	1019.6	0
	700	5	172	10.5	1015.9	3
	1300	7	254	12.7	1013.1	0
	1900	5	341	9.9	1016.9	0
8	100	3	340	7.6	1019.6	0
	700	3	10	7.4	1022.3	5
	1300	2	94	12.0	1022.3	0
	1900	4	135	8.4	1021.6	0
9	100	6	155	11.1	1019.6	0
	700	5	186	11.8	1019.2	0
	1300	6	218	18.7	1015.2	0
	1900	8	192	16.7	1013.1	0
10	100	10	191	16.7	1008.4	0
	700	13	196	18.3	1004.3	0
	1300	14	196	20.2	999.9	0
	1900	9	354	8.3	1005.0	0
11	100	7	2	8.0	1008.7	0
	700	10	22	6.1	1011.1	16
	1300	6	24	7.6	1011.4	0
	1900	2	68	6.4	1010.4	0
12	100	3	170	6.9	1009.4	0
	700	9	323	6.5	1011.1	0
	1300	2	55	8.7	1016.5	0
	1900	7	12	7.0	1021.3	0
13	100	3	143	5.5	1023.3	0
	700	5	152	6.0	1025.0	0
	1300	6	81	16.0	1021.9	0
	1900	11	199	14.0	1019.2	0
14	100	10	217	13.6	1018.2	0
	700	9	223	13.2	1019.2	0
	1300	8	244	18.2	1017.9	0
	1900	5	209	16.6	1019.2	0
15	100	6	207	13.1	1019.6	0
	700	6	201	13.7	1020.9	0
	1300	9	201	21.4	1018.6	0
	1900	10	189	17.9	1017.5	0
16	100	10	199	17.7	1016.5	0
	700	9	199	18.5	1015.5	0
	1300	10	201	21.3	1013.1	0
	1900	9	241	18.5	1013.1	0

\* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Feb 1990

Day	Hour	** Wind	** Wind	Temperature	Atm	Precipitation ***
		Speed m/sec	Direction deg TN	deg C	mb	mm
17	100	8	228	16.6	1011.8	0
	700	3	260	15.8	1015.2	0
	1300	4	47	12.3	1019.2	0
	1900	13	5	8.4	1027.7	0
18	100	11	31	5.8	1031.8	0
	700	9	57	5.7	1033.5	0
	1300	7	20	7.8	1031.8	0
	1900	6	63	7.7	1028.0	0
19	100	0		9.2	1022.3	0
	700	2	17	9.6	1016.9	17
	1300	1	325	10.5	1014.8	0
	1900	5	257	11.3	1014.8	0
20	100	11	340	10.0	1017.9	0
	700	15	3	6.4	1024.3	2
	1300	11	359	5.4	1028.7	0
	1900	8	21	4.4	1031.4	0
21	100	7	51	4.6	1033.1	0
	700	8	44	5.4	1033.8	0
	1300	5	41	8.0	1032.8	0
	1900	4	61	8.2	1030.7	0
22	100	3	126	8.1	1029.1	0
	700	5	140	9.6	1024.7	0
	1300	15	175	19.1	1018.2	0
	1900	13	179	17.9	1013.1	0
23	100	7	187	15.2	1009.4	0
	700	9	200	14.4	1008.7	9
	1300	10	203	17.1	1005.7	0
	1900	10	201	16.4	1002.3	0
24	100	7	217	14.0	998.2	0
	700	12	271	7.4	1005.0	11
	1300	10	240	10.9	1006.4	0
	1900	10	277	7.2	1010.8	0
25	100	11	282	3.3	1016.5	0
	700	12	289	-1.2	1024.3	0
	1300	11	307	0.8	1028.0	0
	1900	12	310	-1.4	1033.5	0
26	100	11	312	-4.0	1038.2	0
	700	10	4	-2.7	1040.6	0
	1300	6	359	-1.2	1041.2	0
	1900	4	38	-1.8	1040.2	0
27	100	4	67	0.2	1038.2	0
	700	3	312	1.3	1036.5	0
	1300	5	203	5.0	1031.4	0
	1900	7	203	7.2	1027.0	0
28	100	4	210	7.0	1025.3	0
	700	5	325	7.1	1025.3	0
	1300	6	13	8.4	1025.7	0
	1900	3	78	7.3	1025.0	0
		Resultant		Mean	Mean	Total
		2	247	10.2	1019.3	69

\* electronic problems

(Sheet 2 of 2)

\*\* Anemometer at end of pier used (gage No. 932)

\*\*\* Precipitation data was read daily from backup gage

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_m$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_m$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Feb 1990

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo,m T.sec	Baylor at 18+60	Hmo,m T.sec	Pressure Gage	Hmo,m T.sec	Offshr Wvrdr	Hmo,m T.sec
1	0100	0.56	10.67	0.87	10.67	0.96	10.24	1.08	6.09
	0700	0.61	10.24	0.85	10.24	0.94	10.24	1.03	9.85
	1300			Power Failure					
	1900	0.64	10.24	0.78	9.85	0.86	9.48	1.01	9.85
2	0100	0.56	5.12	0.73	10.67	0.85	11.13	0.96	9.85
	0700	0.50	10.67	0.62	9.85	0.70	10.24	0.81	9.48
	1300	0.45	15.06	0.57	10.24	0.68	15.06	0.83	15.06
	1900	0.46	9.85	0.52	14.22	0.61	14.22	0.79	9.85
3	0100	0.42	5.57	0.50	16.00	0.63	10.24	0.76	9.85
	0700	0.38	15.06	0.48	15.06	0.53	9.85	0.66	9.85
	1300	0.54	2.81	0.61	2.98	0.52	14.22	0.69	9.85
	1900	0.80	4.57	0.92	4.92	0.97	4.74	1.20	4.57
4	0100	0.64	4.83	0.96	6.09	1.09	6.24	1.20	6.40
	0700	0.71	6.24	0.82	7.11	0.94	6.24	0.98	6.40
	1300	0.72	5.95	0.85	7.76	0.94	7.53	1.04	6.56
	1900	0.59	8.00	0.69	8.53	0.79	8.00	1.03	7.53
5	0100	1.98	6.40	1.86	6.24	2.13	6.24	2.29	6.24
	0700	1.87	8.26	1.95	8.26	2.31	7.53	2.50	8.26
	1300	1.54	8.83	1.64	9.14	1.80	8.53	1.86	9.14
	1900	1.22	9.85	1.36	9.85	1.45	10.24	1.64	9.85
6	0100	1.26	12.19	1.67	12.19	1.62	11.64	1.75	12.19
	0700	0.91	10.24	1.23	10.67	1.33	12.19	1.33	12.19
	1300	0.70	11.64	1.02	11.64	1.20	12.19	1.22	12.19
	1900	0.52	12.19	0.94	12.19	1.04	11.64	1.04	12.19
7	0100	0.41	12.19	0.65	12.19	0.90	12.19	0.82	12.19
	0700	0.37	12.80	0.63	12.19	0.65	12.80	0.69	12.80
	1300	0.33	12.19	0.53	12.19	0.61	10.67	0.65	12.80
	1900	0.31	12.19	0.46	11.64	0.50	11.64	0.56	12.19
8	0100	0.33	12.19	0.42	10.67	0.46	11.64	0.53	12.19
	0700	0.31	12.19	0.44	11.64	0.45	12.19	0.53	11.64
	1300	0.31	12.19	0.41	10.67	0.47	11.13	0.49	11.13
	1900	0.32	11.64	0.46	10.67	0.55	12.19	0.59	7.31
9	0100	0.32	12.80	0.47	7.76	0.50	10.67	0.56	6.92
	0700	0.32	8.26	0.49	6.92	0.54	7.76	0.59	11.64
	1300	0.34	12.19	0.47	7.53	0.52	12.19	0.61	7.31
	1900	0.37	5.69	0.50	9.85	0.57	12.80	0.73	5.95
10	0100	0.48	2.61	0.51	12.80	0.56	9.85	0.75	9.85
	0700	0.53	7.11	0.65	6.74	0.70	6.92	0.69	6.40
	1300	0.68	8.00	0.64	8.83	0.75	7.76	0.66	7.53
	1900	0.98	5.57	1.01	5.22	1.16	5.22	1.54	5.33
11	0100	0.93	4.57	0.75	4.57	0.83	4.66	0.99	4.49
	0700	1.45	5.69	1.38	5.57	1.56	5.69	1.79	5.57
	1300	1.20	6.40	1.07	6.40	1.25	6.56	1.38	6.74
	1900	0.72	5.22	0.87	6.74	0.93	5.82	2.78	17.07
12	0100	0.57	5.95	0.64	7.11	0.75	5.82	0.87	6.74
	0700	0.46	5.69	0.63	8.00	0.64	8.00	0.85	8.00
	1300	1.30	5.45	0.98	5.57	1.14	5.22	1.47	5.57
	1900	0.86	5.12	0.79	5.22	0.88	4.92	1.01	5.02
13	0100	0.47	4.92	0.44	5.02	0.47	5.02	0.66	4.57
	0700	0.39	5.02	0.46	8.53	0.50	8.00	0.57	7.76
	1300	0.32	8.00	0.47	8.00	0.50	8.26	0.69	8.83
	1900	0.30	8.26	0.44	8.00	0.50	8.26	0.82	3.61
14	0100	0.30	8.26	0.37	8.26	0.44	8.83	0.79	8.83
	0700	0.22	8.00	0.31	8.53	0.37	8.00	0.51	8.00
	1300	0.22	9.48	0.28	9.85	0.32	9.85	0.40	9.14
	1900	0.28	9.85	0.32	10.67	0.38	10.67	0.40	9.85
15	0100	0.21	10.24	0.31	10.24	0.36	10.67	0.41	10.67
	0700	0.22	10.24	0.30	10.67	0.36	10.67	0.43	10.67
	1300	0.26	11.64	0.34	10.67	0.38	10.67	0.50	11.13
	1900	0.36	12.80	0.45	11.13	0.46	11.13	0.71	6.40
16	0100	0.47	6.56	0.52	7.31	0.64	7.11	0.88	7.11
	0700	0.45	7.31	0.56	7.31	0.66	7.11	0.91	7.53
	1300	0.49	7.53	0.60	7.53	0.75	7.76	1.04	6.92
	1900	0.57	7.53	0.58	7.53	0.70	8.00	1.06	8.00

\* Electronic problems

(Continued)

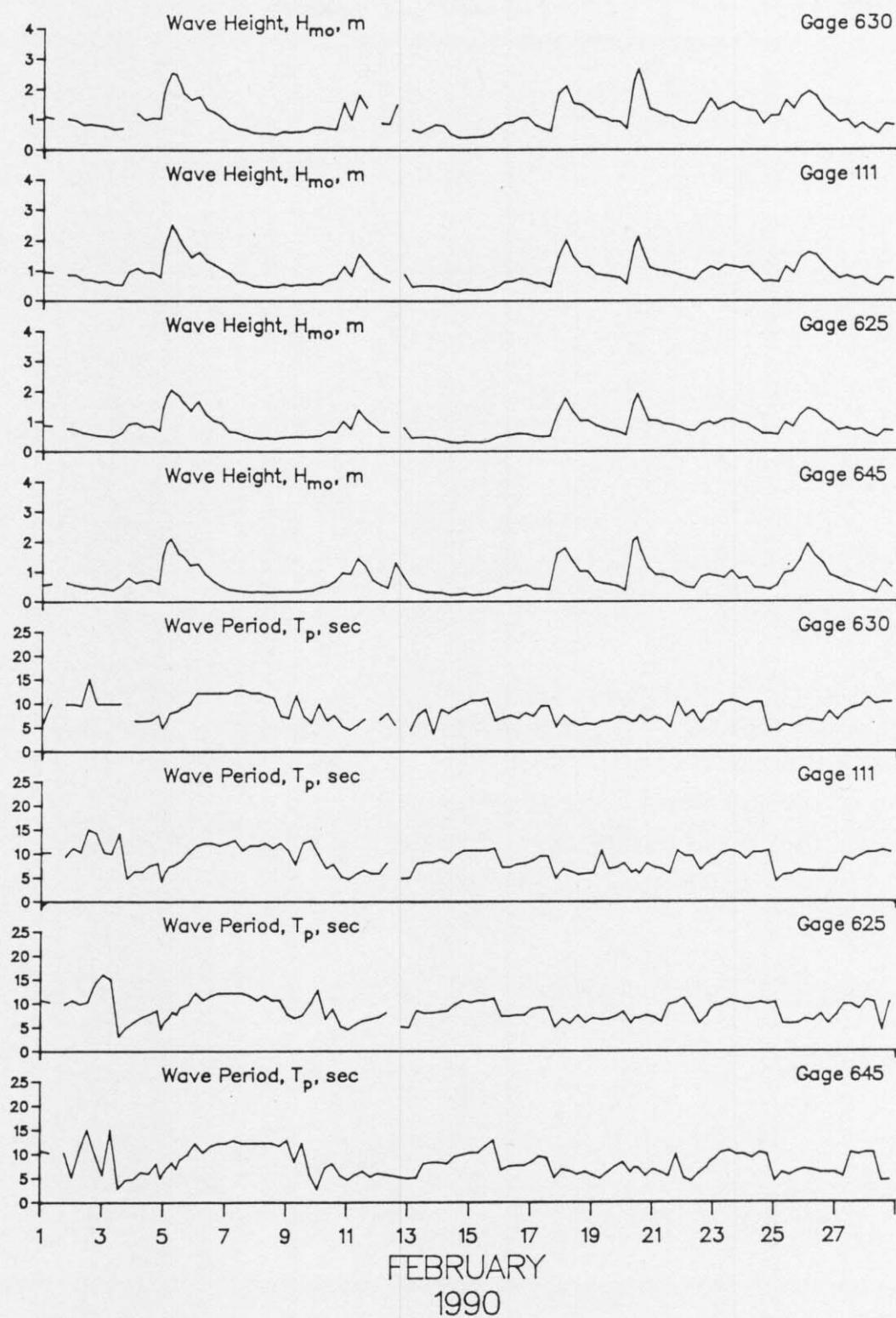
Table 3: Wave Data

Feb 1990

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo, m T, sec	Baylor at 18+60	Hmo, m T, sec	Pressure Gage	Hmo, m T, sec	Offshr Wvrdr	Hmo, m T, sec
17	0100	0.43	8.26	0.51	8.83	0.60	8.53	0.80	7.31
	0700	0.42	9.48	0.49	9.14	0.59	9.48	0.69	9.48
	1300	0.40	9.14	0.50	9.14	0.46	9.48	0.61	9.48
	1900	1.61	5.02	1.27	5.02	1.45	4.83	1.86	5.12
18	0100	1.79	6.74	1.76	6.74	2.02	6.74	2.09	7.53
	0700	1.38	6.40	1.33	5.82	1.46	6.24	1.52	6.24
	1300	1.01	5.69	1.01	7.53	1.15	5.57	1.47	5.45
	1900	1.01	6.24	1.02	5.95	1.11	5.82	1.29	5.82
19	0100	0.69	5.57	0.86	6.92	0.89	5.95	1.07	5.57
	0700	0.60	4.83	0.76	6.56	0.84	10.67	1.04	6.24
	1300	0.56	6.09	0.70	6.74	0.81	6.74	0.92	6.40
	1900	0.51	7.31	0.64	7.31	0.77	7.11	0.91	7.11
20	0100	0.36	8.26	0.53	8.26	0.56	8.00	0.68	7.11
	0700	2.03	6.09	1.61	5.82	1.84	5.95	2.30	6.24
	1300	1.72	7.11	1.61	6.92	1.74	5.82	2.29	7.53
	1900	1.13	5.45	1.02	7.53	1.12	8.00	1.34	6.24
21	0100	0.90	6.74	1.01	7.11	1.02	7.11	1.24	7.11
	0700	0.89	6.09	0.91	6.09	0.99	6.74	1.11	6.56
	1300	0.81	5.33	0.88	9.85	0.93	5.82	1.09	5.02
	1900	0.62	9.85	0.81	10.24	0.85	10.67	0.93	10.24
22	0100	0.48	5.02	0.70	11.13	0.77	9.48	0.86	7.31
	0700	0.44	4.27	0.67	8.83	0.71	9.48	0.84	8.53
	1300	0.83	5.95	0.91	5.82	0.98	6.56	1.25	5.95
	1900	0.91	7.11	0.99	7.31	1.14	8.00	1.69	8.00
23	0100	0.86	8.83	0.94	9.48	1.02	8.83	1.31	8.53
	0700	0.79	10.24	1.07	9.85	1.20	10.24	1.43	10.24
	1300	1.03	10.67	1.08	10.67	1.15	10.67	1.55	10.67
	1900	0.75	9.85	0.97	10.24	1.09	10.24	1.38	10.24
24	0100	0.80	9.85	0.92	9.85	1.14	8.83	1.29	9.48
	0700	0.47	9.14	0.75	9.85	0.89	10.24	1.26	10.24
	1300	0.44	10.24	0.59	10.24	0.63	10.24	0.87	10.24
	1900	0.39	9.85	0.58	9.85	0.66	10.67	1.11	4.27
25	0100	0.54	4.34	0.55	10.24	0.62	4.20	1.12	4.34
	0700	0.96	6.09	0.97	5.82	1.15	5.57	1.64	5.57
	1300	1.01	5.57	0.81	5.69	0.94	5.69	1.36	5.22
	1900	1.37	6.40	1.22	5.82	1.47	6.56	1.76	6.09
26	0100	1.92	6.92	1.43	6.74	1.62	6.40	1.93	6.74
	0700	1.53	6.56	1.33	6.40	1.54	6.24	1.77	6.56
	1300	1.28	6.09	1.07	7.76	1.22	6.24	1.34	6.24
	1900	0.88	6.09	0.93	5.82	0.97	6.24	1.15	8.26
27	0100	0.77	6.09	0.69	7.53	0.75	6.24	0.90	6.56
	0700	0.63	5.22	0.77	9.85	0.83	9.14	0.97	8.26
	1300	0.56	10.24	0.69	9.85	0.73	8.53	0.70	9.14
	1900	0.48	9.85	0.73	8.83	0.78	9.48	0.86	9.48
28	0100	0.38	10.24	0.56	10.67	0.58	10.24	0.67	11.13
	0700	0.27	10.24	0.47	10.24	0.50	10.24	0.53	9.85
	1300	0.72	4.34	0.69	4.34	0.78	10.67	0.83	10.24
	1900	0.48	4.49	0.67	10.24	0.74	10.24	0.80	10.24
Mean		0.71	8.01	0.79	8.62	0.89	8.67	1.07	8.29
Std dev		0.43	2.73	0.36	2.39	0.40	2.43	0.48	2.49

\* Electronic problems

(Sheet 2 of 2)



#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Feb 1990

Day	Time	Pier Measurements				Beach Measurements			Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	Depth -5.6m (NGVD)
1	0100-Along Cross Result									0.9 km Offshore
	Speed	Dir								Depth -5.6m
	13	S								(NGVD)
	3	on	140	68	N					ID #519
	13	174		0		South	3	N		Speed
				68	340					Dir
1	0700-Along Cross Result	13	5							20
	3	on	140	68	N					9
	13	174		0		South	9	off		22
				68	340					136
1	1300-Along Cross Result									15
										S
1	1900-Along Cross Result									9
										off
1	1900-Along Cross Result									17
										129
2	0100-Along Cross Result									13
										S
2	0700-Along Cross Result	0								0
	7	off	152	68	N					13
	7	70		0		South	12	S		160
				68	340					S
2	1300-Along Cross Result									6
										S
2	1900-Along Cross Result									0
										6
2	1900-Along Cross Result									160
										N
3	0100-Along Cross Result	17	S							4
	10	on	140	24	N					4
	20	191		2	on	South	15	N		off
				25	334					5
3	0700-Along Cross Result									17
										S
3	1300-Along Cross Result	17	S							6
	10	on	140	24	N					1
	20	191		2	on	South	12	S		on
				25	334					6
3	1900-Along Cross Result									169
										S
3	1900-Along Cross Result									16
										off
3	1900-Along Cross Result									19
										128
4	0100-Along Cross Result									16
										S
4	0700-Along Cross Result	16	S							7
	0		140	24	S					off
	16	160		15	on	North	5	N		18
				28	191					124
4	1300-Along Cross Result									31
										S
4	1900-Along Cross Result									19
										off
4	1900-Along Cross Result									25
										120
5	0100-Along Cross Result									19
										S
5	0700-Along Cross Result	61	S							0
	0		152	102	S					19
	61	160		71	on	South	71	S		160
				124	195					S
5	1300-Along Cross Result									44
										off
5	1900-Along Cross Result									16
										47
										140
										S
										off
										47
										137
										S
										33
										off
										11
										35
										142
										S
										off
										33
										13
										138

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)  
Feb 1990

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed
6	0100-Along Cross Result									0.9 km Offshore Depth -5.6m (NGVD) ID #519
6	0700-Along Cross Result	0			51	S		38 N		22 S
6	10 off	10	152	30	on		North			6 off
6	1300-Along Cross Result	10	101	59	191					23 145
6	1900-Along Cross Result									11 N
7	0100-Along Cross Result									12 on
7	0700-Along Cross Result	51	N		68	N		5 S		16 293
7	0 off	0	140	27	off		South			4 N
7	1300-Along Cross Result	51	340	73	2					5 on
7	1900-Along Cross Result									6 289
8	0100-Along Cross Result									14 N
8	0700-Along Cross Result	24	N		41	N		5 S		6 on
8	0 off	0	128	0			South			15 317
8	1300-Along Cross Result	24	340	41	340					17 N
8	1900-Along Cross Result									9 on
9	0100-Along Cross Result									19 312
9	0700-Along Cross Result	17	N		61	N		5 S		5 N
9	0 off	7	128	0			South			0 on
9	1300-Along Cross Result	18	2	61	340					5 340
9	1900-Along Cross Result									5 S
10	0100-Along Cross Result									2 off
10	0700-Along Cross Result	68	N		102	N		41 N		6 142
10	0 off	27	152	0			South			7 off
10	1300-Along Cross Result	73	2	102	340					25 S
10	1900-Along Cross Result									7 119

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)  
Feb 1990

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m updrift)			Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
11 0100-Along Cross Result								15	S
								4	off
								16	145
11 0700-Along Cross Result	44	S		68	S		20 S	23	S
	0		152	17	on			9	off
	44	160		70	174			25	139
11 1300-Along Cross Result								24	S
								10	off
								26	137
11 1900-Along Cross Result								9	S
								0	
								9	160
12 0100-Along Cross Result								8	S
								3	off
								9	139
12 0700-Along Cross Result	61	S		0			51 S	6	N
	0		128	0				7	on
	61	160		0	0			9	291
12 1300-Along Cross Result								13	S
								3	off
								13	147
12 1900-Along Cross Result								34	N
								12	off
								36	359
13 0100-Along Cross Result								45	N
								8	off
								46	350
13 0700-Along Cross Result	9	N		14	N		5 N	42	N
	2	off	128	3	off			0	
	9	354		14	354			42	340
13 1300-Along Cross Result								4	S
								0	
								4	160
13 1900-Along Cross Result								7	N
								12	on
								14	280
14 0100-Along Cross Result								4	N
								10	on
								11	272
14 0700-Along Cross Result	20	N		36	S		3 N	8	N
	20	off	128	0				10	on
	29	25		36	160			13	289
14 1300-Along Cross Result								6	N
								8	on
								10	287
14 1900-Along Cross Result								7	N
								5	on
								9	304
15 0100-Along Cross Result								4	S
								1	on
								4	174
15 0700-Along Cross Result	24	N		32	N		10 N	1	S
	18	off	140	0				2	on
	30	17		32	340			2	223
15 1300-Along Cross Result								3	S
								2	on
								4	194
15 1900-Along Cross Result								4	N
								3	on
								5	303

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)  
Feb 1990

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter		
		Alongshore Resultant	Cross-shore Resultant	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
16	0100-Along Cross Result									4	N
										3	on
										5	303
16	0700-Along Cross Result	47	N		140	102	N		23 N	12	N
		0				25	on			6	on
		47	340			105	326			13	313
16	1300-Along Cross Result									9	N
										6	on
										11	306
16	1900-Along Cross Result									13	N
										8	on
										15	308
17	0100-Along Cross Result									6	N
										7	on
										9	291
17	0700-Along Cross Result	11	S		140	41	N		41 N	4	N
		1	on			0				5	on
		11	166			41	340			6	289
17	1300-Along Cross Result									6	S
										5	off
										8	120
17	1900-Along Cross Result									19	S
										9	off
										21	135
18	0100-Along Cross Result									35	S
										16	off
										38	135
18	0700-Along Cross Result	11	S		152	76	S		38 S	17	S
		3	on			46	on			10	off
		12	177			89	191			20	130
18	1300-Along Cross Result									35	S
										18	off
										39	133
18	1900-Along Cross Result									33	S
										15	off
										36	136
19	0100-Along Cross Result									22	S
										16	off
										27	124
19	0700-Along Cross Result	36	S		140	47	N		15 N	26	S
		9	off			0				11	off
		37	146			47	340			28	137
19	1300-Along Cross Result									15	S
										11	off
										19	124
19	1900-Along Cross Result									4	S
										0	
										4	160
20	0100-Along Cross Result									12	N
										7	on
										14	310
20	0700-Along Cross Result	55	S		152	152	S		91 S	36	S
		14	on			30	on			16	off
		57	174			155	171			39	136
20	1300-Along Cross Result									24	S
										10	off
										26	137
20	1900-Along Cross Result									22	S
										8	off
										23	140

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Feb 1990

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed
21	0100-Along Cross Result									10
										S
										8
										off
										13
										121
21	0700-Along Cross Result	23	S			18	S			15
		6	off			4	off			7
		24	146	152		18	146	North		17
										135
21	1300-Along Cross Result									13
										S
										2
										off
										13
										151
21	1900-Along Cross Result									13
										S
										9
										off
										16
										125
22	0100-Along Cross Result									5
										S
										2
										off
										5
										138
22	0700-Along Cross Result	5	N			68	N			3
		1	off			0				3
		5	351	140		68	340	South		4
										115
22	1300-Along Cross Result									20
										N
										12
										on
										23
										309
22	1900-Along Cross Result									14
										N
										12
										on
										18
										299
23	0100-Along Cross Result									16
										N
										12
										on
										20
										303
23	0700-Along Cross Result	20	N			122	N			17
		24	off			12	on			9
		32	30	152		123	334	South		19
										312
23	1300-Along Cross Result									24
										N
										11
										on
										26
										315
23	1900-Along Cross Result									24
										N
										11
										on
										26
										315
24	0100-Along Cross Result									25
										N
										11
										on
										27
										316
24	0700-Along Cross Result	0				0				7
		20	off			152				5
		20	70			15	off			9
						15	70	South		304
24	1300-Along Cross Result									13
										N
										8
										on
										15
										308
24	1900-Along Cross Result									10
										N
										2
										on
										10
										329
25	0100-Along Cross Result									5
										S
										1
										off
										5
										149
25	0700-Along Cross Result	47	S			30	S			8
		0				5	off			5
		47	160	140		31	151	North		9
										128
25	1300-Along Cross Result									9
										S
										4
										off
										10
										136
25	1900-Along Cross Result									16
										S
										9
										off
										18
										131

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Concluded)  
Feb 1990

Day	Time	Pier Measurements				Beach Measurements			Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)	(500m Updrift)	Location	Speed	Dir	Depth -5.6m (NGVD)	ID #519
26	0100-Along Cross Result								0.9 km Offshore	
	Day	Speed	Dir						Depth -5.6m	
26	0700-Along Cross Result	36	S		87	S	63	S	(NGVD)	ID #519
		18	off	140	30	off	North			
		40	133		92	141				
26	1300-Along Cross Result								Speed	Dir
									25	S
26	1900-Along Cross Result								13	off
									28	133
27	0100-Along Cross Result									
									19	S
27	0700-Along Cross Result	55	S		30	S	10	S	10	S
		8	off	128	0		South		7	off
		56	151		30	160			12	125
27	1300-Along Cross Result								8	S
									18	
27	1900-Along Cross Result								15	off
									23	120
28	0100-Along Cross Result								3	S
									5	on
28	0700-Along Cross Result	19	S		22	S	33	S	6	219
		17	on	140	13	on	North		10	N
		26	202		25	191			2	on
28	1300-Along Cross Result								10	329
									12	N
28	1900-Along Cross Result								6	on
									13	313
									1	N
									9	off
									9	64
									11	N
									3	on
									11	325

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

#### PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Feb 1990

Day	Time	Wave Approach		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0830	80			61	8.9	1.0253	1.8
2	0720	110			44	8.3	1.0235	2.7
3	1150	35			59	9.4	1.0240	4.3
4	1100	100	50		59	9.4	1.0226	5.5
5	0815	40	0	50	422	8.3	1.0224	0.6
6	0815	60	70		195	7.8	1.0220	1.5
7	0810	90			37	8.3	1.0220	1.8
8	0830	50			24	8.3	1.0222	4.6
9	0830	65	120		28	8.3	1.0218	3.4
10	0950	110			52	8.9	1.0244	0.9
11	1045	55			143	9.4	1.0249	1.5
12	0820	5			40	8.9	1.0250	1.8
13	0810	55	95		30	8.9	1.0234	2.7
14	0830	90	120		27	8.9	1.0249	4.0
15	0820	115			37	8.9	1.0252	4.3
16	0830	90	115		47	10.0	1.0248	3.0
17	1015	90	10		47	9.4	1.0250	3.0
18	0915	30	70		113	10.0	1.0251	0.9
19	0830	95			67	10.0	1.0200	3.0
20	0820	30			449	9.4	1.0210	1.5
21	0840	30	60		118	8.9	1.0202	2.4
22	0835	90	100		73	9.4	1.0202	2.1
23	0905	100	110		61	10.0	1.0251	1.5
24	1020	95			68	10.0	1.0252	1.2
25	0950	40			59	8.9	1.0254	1.8
26	0840	40	15		98	7.8	1.0256	1.2
27	0830	65	85		49	7.8	1.0239	2.7
28	0905	35		40	12	8.0	1.0244	2.4

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

## FRF Tide Heights

Feb 1990

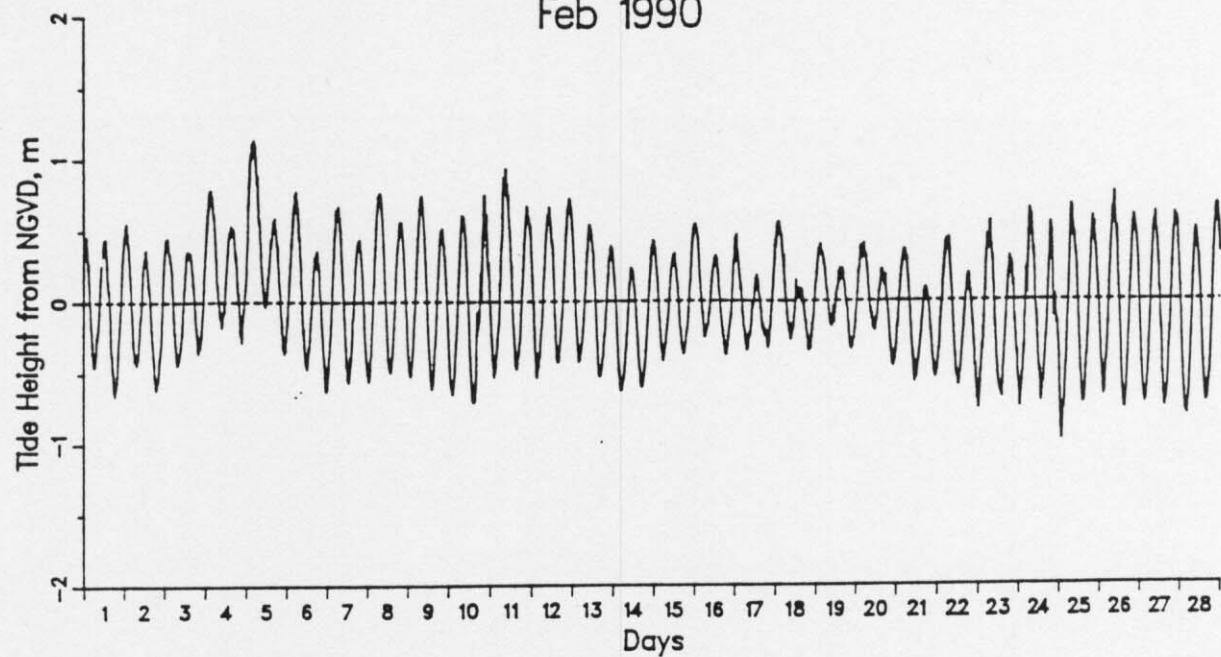


Figure 4. Water Level Time History

### Monthly Water Levels, m NGVD

Extreme Low	=	-0.98	on day 25	at 36 EST
Extreme High	=	1.14	on day 5	at 336 EST
Monthly Mean	=	0.01		
Mean Low	=	-0.50		
Mean High	=	0.59		
Mean Range	=	1.09		

Table 6: Water Levels, m NGVD

		Feb 1990			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	612	-0.45	0.46	0.02	0.91
1	1837	-0.66	0.55	-0.09	1.21
2	703	-0.44	0.48	-0.01	0.92
2	1928	-0.62	0.45	-0.13	1.06
3	753	-0.44	0.37	-0.01	0.81
3	2018	-0.36	0.79	0.14	1.15
4	843	-0.18	0.76	0.25	0.93
4	2109	-0.28	1.13	0.33	1.41
5	934	-0.03	1.14	0.43	1.17
5	2159	-0.36	0.75	0.15	1.11
6	1024	-0.47	0.78	0.05	1.25
6	2249	-0.63	0.64	-0.06	1.27
7	1115	-0.56	0.67	0.02	1.23
7	2340	-0.56	0.75	0.04	1.31
8	1205	-0.50	0.77	0.11	1.26
9	30	-0.52	0.72	0.06	1.25
9	1255	-0.61	0.74	0.03	1.36
10	121	-0.65	0.61	-0.04	1.26
10	1346	-0.70	0.75	-0.07	1.45
11	211	-0.53	0.93	0.13	1.46
11	1436	-0.47	0.83	0.14	1.30
12	301	-0.53	0.61	0.06	1.15
12	1527	-0.43	0.72	0.14	1.15
13	352	-0.43	0.68	0.10	1.11
13	1617	-0.53	0.50	-0.04	1.03
14	442	-0.63	0.34	-0.17	0.96
14	1707	-0.61	0.42	-0.15	1.03
15	532	-0.42	0.37	-0.01	0.79
15	1758	-0.37	0.54	0.03	0.91
16	623	-0.26	0.51	0.08	0.77
16	1848	-0.37	0.47	-0.02	0.84
17	713	-0.34	0.34	-0.05	0.68
17	1938	-0.33	0.56	0.04	0.88
18	804	-0.27	0.52	0.03	0.79
18	2029	-0.34	0.40	-0.01	0.74
19	854	-0.17	0.34	0.07	0.52
19	2119	-0.34	0.38	-0.01	0.72
20	944	-0.20	0.41	0.06	0.61
20	2210	-0.46	0.36	-0.08	0.81
21	1035	-0.57	0.34	-0.15	0.91
21	2300	-0.54	0.43	-0.12	0.97
22	1125	-0.59	0.45	-0.14	1.04
22	2350	-0.76	0.47	-0.17	1.23
23	1216	-0.68	0.56	-0.14	1.24
24	41	-0.75	0.64	-0.09	1.39
24	1306	-0.71	0.59	-0.07	1.30
25	131	-0.98	0.67	-0.18	1.64
25	1356	-0.72	0.59	-0.06	1.31
26	222	-0.67	0.76	0.02	1.43
26	1447	-0.76	0.62	-0.05	1.38
27	312	-0.72	0.62	-0.07	1.34
27	1537	-0.75	0.61	-0.05	1.37
28	402	-0.81	0.57	-0.15	1.37
28	1628	-0.72	0.68	-0.07	1.39
29	453	0.33	0.58	0.46	0.25

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in January and the two surveys in February on profile line 188, located 517 m south of the pier. Only minor changes are visible.

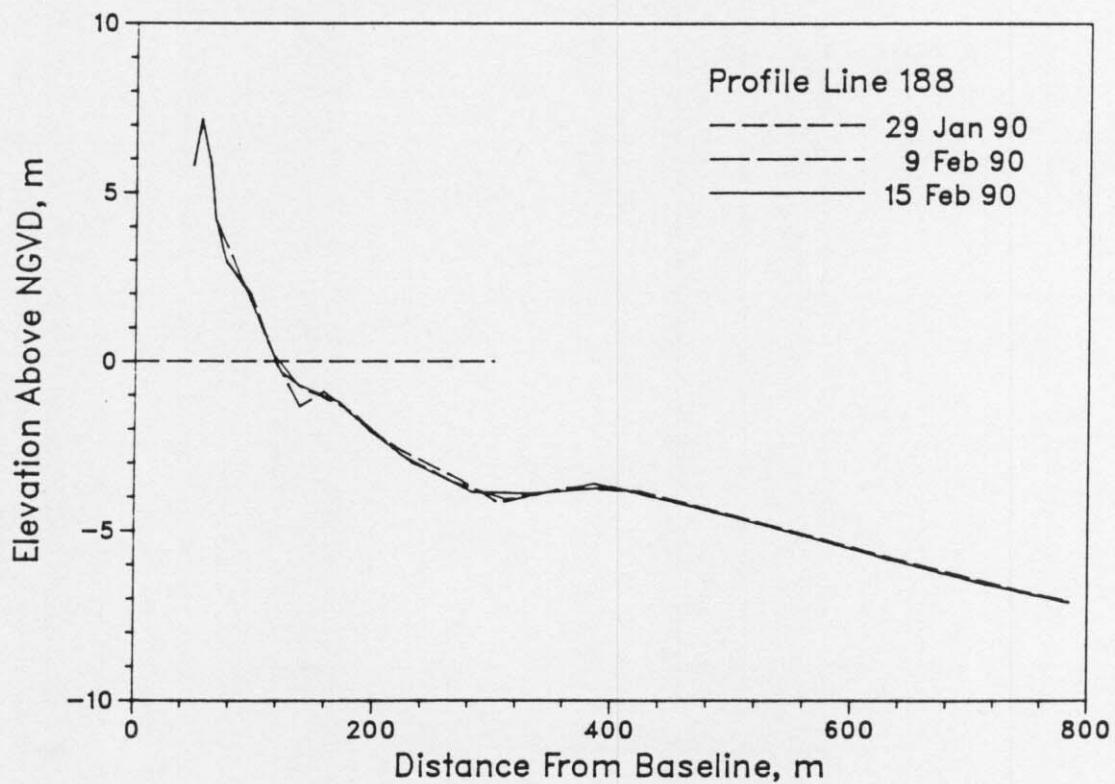


Figure 5. Monthly CRAB profiles on profile 188 -  
517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1990.

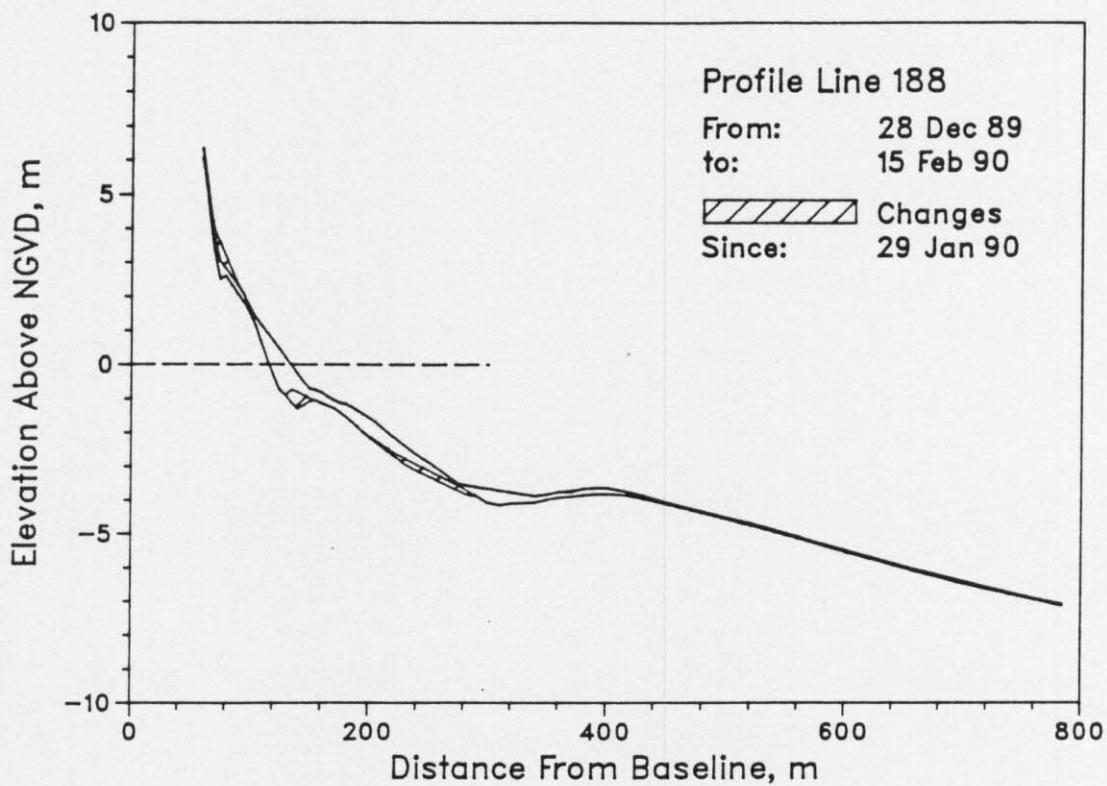


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 16 February. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

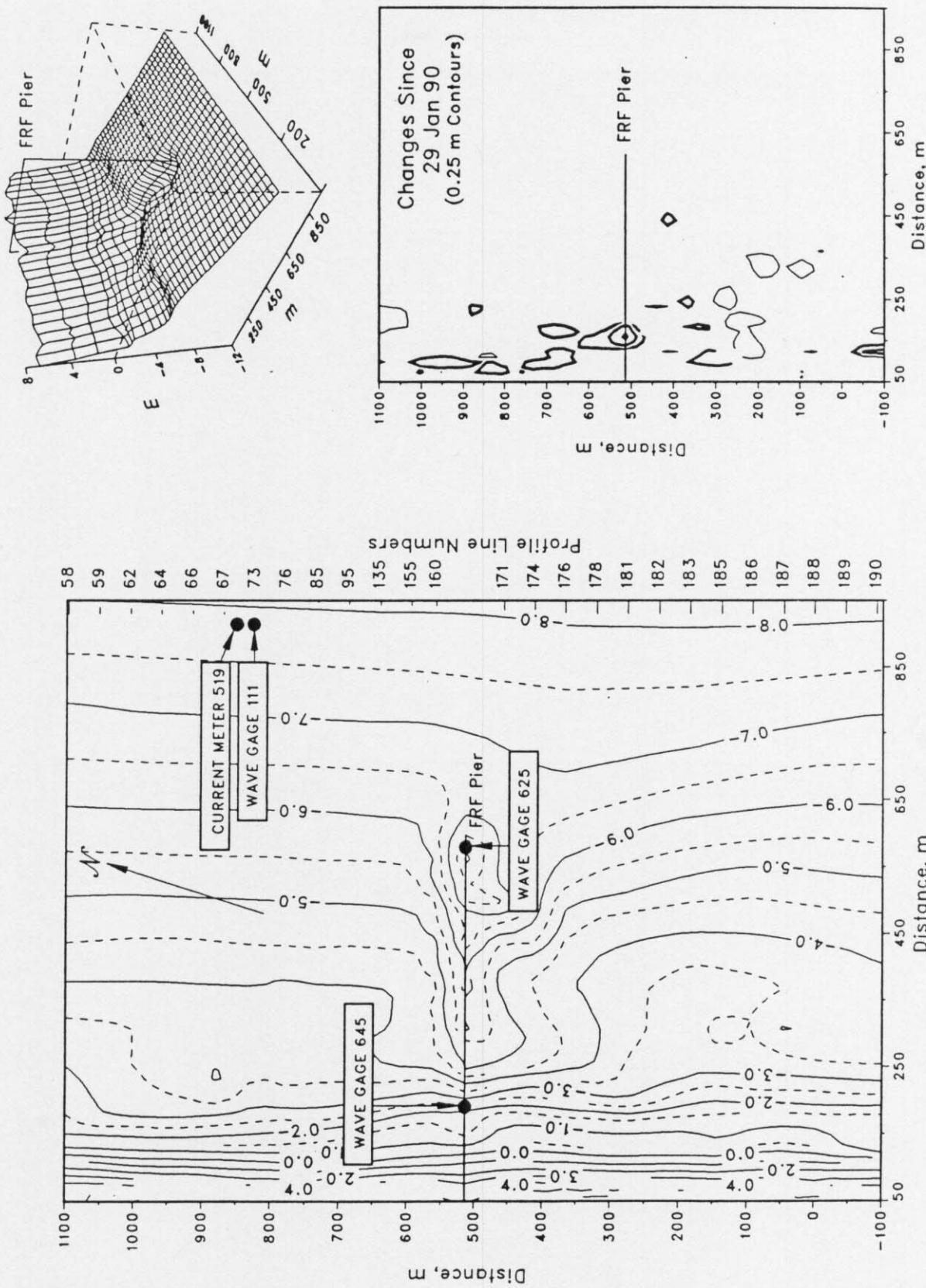


Figure 7. FRF bathymetry 16 Feb 90 depths relative to NGVD

## PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
5 Feb (0242)	5 Feb (0808)

B. Storm Synopsis.

5 February - Following the passage of a cold front, strong northerly winds generated by a high pressure system began to affect the FRF late on 4 February. Peak northerly winds exceeding 19 m/s were recorded at 2200 hours on 4 February. The maximum  $H_{so}$  (at gage 625) of 2.07 m ( $T_p = 7.31$  sec) occurred at 0508 hours on 5 February.

Distribution List

Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

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California Inst. of Tech.	Stockton State College
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Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
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Queen's University, Ontario (Canada)  
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Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)

